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15 JUL 99 E462149-1 D02823

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1. Your reference HAG/LP5787619

2. Patent application number  
(The Patent Office will fill in this part) **9916558.1**

3. Full name, address and postcode of the or of each applicant (underline all surnames)  
DORMER TOOLS (SHEFFIELD) LIMITED  
ROTHER VALLEY WAY  
HOLBROOK  
SHEFFIELD S20 3RW

Patents ADP number (if you know it) 07701089001

If the applicant is a corporate body, give the country/state of its incorporation UK

4. Title of the invention METHOD AND MEANS FOR DRILL PRODUCTION

5. Name of your agent (if you have one) MEWBURN ELLIS

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)  
YORK HOUSE  
23 KINGSWAY  
LONDON  
WC2B 6HP

Patents ADP number (if you know it) 109006

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number	Country	Priority application number (if you know it)	Date of filing (day / month / year)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application	Date of filing (day / month / year)

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:

- a) any applicant named in part 3 is not an inventor, or
- b) there is an inventor who is not named as an applicant, or
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See note (d)) YES

# Patents Form 1/77

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Description 12

Claim(s) 3

Abstract 1

Drawing(s) 4 24

10. If you are also filing any of the following, state how many against each item

Priority documents 0

Translations of priority documents 0

Statement of inventorship and right to grant of a patent (Patents Form 7/77) 0

Request for preliminary examination and search (Patents Form 9/77) 0

Request for substantive examination (Patents Form 10/77) 0

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11. I/We request the grant of a patent on the basis of this application.

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13 July 1999

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## METHOD AND MEANS FOR DRILL PRODUCTION

This invention relates to the production of drills and in particular to the application of coatings, such as ceramic coatings, to drills.

5 ~~It is known to coat the point and flutes of a~~  
fluted high speed steel drill with a ceramic such as titanium nitride or aluminium titanium nitride to improve wear or cutting performance. The application of such coatings adds considerably to the cost of the drill,  
10 however.

It would be possible to lower the cost by limiting the coating to the drill point and the region immediately behind the point, but the cost of the coating material although significant, is only one factor of the  
15 total cost. Ceramic coatings are typically applied by physical vapour deposition (PVD) in a vacuum chamber, by such processes as evaporative arc or electron beam or sputtering, and the considerable cost of operating such equipment is a major factor, but there is little  
20 difference in process time with the length of the drill being coated.

The present invention aims to provide an improved method and means by which a coating can be applied to drills, in particular to apply a coating to a limited  
25 portion at and near the drill tip to provide a wider commercial application for coated drills.

According to one aspect of the invention, a hollow holder

is provided for supporting a series of drills in a vapour deposition chamber to allow a ceramic coating to be deposited on tip regions of the drills, the holder having at least one perforated outer wall provided with an array  
5 of apertures into which the drills can be inserted with

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said tip regions projecting outwards from the holder, within the holder there being provided supports for the inserted drills in the or each said wall for locating the drills with their shanks substantially parallel and stop  
10 means for locating the tips of drills of the same diameter projecting to the substantially same extent from said outer wall.

The stop means can be formed by a back wall in the interior of the holder, parallel to said outer wall.  
15 An inner wall can be arranged between the outer and back walls and parallel to both, with a corresponding array of apertures to that in the outer wall to hold the drills with their shanks parallel.

Typically, the active zone of a PVD chamber is  
20 close to its inside wall. To assist even application of the coating, it is known to rotate the articles to be coated to vary continuously the exposure of the surfaces to the vapour. Thus, by using a turntable the articles can be circulated along the periphery of the rotary path.  
25 It is also known to mount articles to be coated on planetary carriers rotating on axes parallel to the turntable axis, so that the articles are given a double rotation.

To aid the efficient use of such a planetary motion system, according to another aspect of the invention a hollow holder is provided for supporting a series of drills in a vapour deposition chamber to allow  
5 a ceramic coating to be deposited on tip regions of the

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drills, the holder having a hexagonal plan form comprising alternate perforated outer walls provided with an array of apertures into which the drills can be inserted with said tip regions projecting outwards, said  
10 holder providing supports for the inserted drills in each said wall to locate the drills with their shanks substantially parallel and with the tips of drills of the same diameter projecting to substantially the same extent from each outer wall.

15 A perforated inner wall can be arranged in the holder, parallel to each outer wall and provided with a corresponding array of apertures, and a back wall can be arranged behind and parallel to each such pair of perforated walls, against which the rear of the drills  
20 can abut to set their depth of insertion.

The walls of the hollow holders according to the invention may be relatively thin to keep the thermal mass of the holders low, giving quicker heating and cooling at the beginning and end of the vapour deposition cycle, so  
25 as to reduce the cycle time. It is known to admit an inert gas into the chamber at the end of the cycle to increase the rate of cooling and preferably the holders are so arranged that the gas is allowed to circulate

through the hollow interior of the holders also. However, the shanks of the drills must be shielded from the deposition material if they are not also to be coated, so the tops of the holders must be closed.

5           In accordance with a preferred feature of the invention, the holder is provided with a lid that shields the hollow interior from above, said lid being provided with a passage for facilitating the venting and cooling of said interior after application of the PVD coating.

10           According to another aspect of the invention there is provided a method of vapour-deposition coating the tips of a series of drills in which the drills are inserted in a hollow holder having a polygonal plan form with the tips to be coated projecting from at least one  
15   outer face of said polygonal form, the holder with the inserted tips being rotated in a vapour deposition chamber to allow each of the drill tips to project from the holder towards the periphery of the chamber for at least a part of the processing period, and a gas being  
20   allowed to circulate through the holder interior after deposition of the coating to assist cooling of the drills.

The invention will be described by way of example with reference to the accompanying drawings, in which:

25           Figs. 1 to 3 are side, and transverse sectional plan views respectively of a first form of holder according to the invention,

Figs. 4 and 5 are side and plan views of another

form of holder according to the invention,

Figs. 6 and 7 are plan and transverse sectional views of a mounting for the holder of Figs. 1 to 3,

Figs. 8 and 9 are plan and transverse sectional views of a lid for the holder of Figs. 1 to 3,

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Figs. 10 and 11 are side and plan views illustrating a series of holders of the form shown in Figs. 1 to 3 assembled in the form of towers and mounted on a PVD chamber turntable, the chamber being indicated schematically in Fig. 10,

Figs. 12 and 13 are side and plan views of the further form of holder according to the invention, and

Figs. 14 and 15 are plan and side views illustrating a carrier for holders of the form shown in Figs. 12 and 13 mounted on a chamber turntable, only one diametrically opposite pair of carrier arms being shown in Fig. 15.

The holders shown in the drawings are designed to permit the tips of fluted high speed steel drills to be given a titanium nitride coating by PVD over about one quarter of the fluted length of the drills. A single drill D is shown in phantom in Fig. 2, to illustrate how each drill is mounted in a holder with its tip projecting to be exposed to the coating vapour, the remainder of the drill shank being shielded by the holder.

The holder 2 of Figs. 1 to 3 has a hexagonal plan form and alternate outer side walls 4 are drilled with a rectangular array of apertures 6 over their walls and

most of their height to receive a bank of drills. The apertures are spaced to leave clearances between adjacent drills approximately equal to their diameter. Behind each perforated outer wall and parallel to it an inner  
5 wall 8 extends across the holder. Each inner wall has a

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corresponding array of apertures (not shown) so that the inserted drills D are held parallel to each other. The apertures of the inner wall are set slightly below those in the outer wall so that the drills can rest stably,  
10 inclined at an angle of about  $2^\circ$  from the horizontal. The depth of insertion of the drills is limited by back walls 10 which present planar abutment faces parallel to each outer wall, over the area of each array of apertures. The back walls are connected to each other to  
15 give a stable sub-assembly which is attached to the outer walls only at three positions around the inner periphery of the outer walls 4.

The drills fit freely in the apertures 6 to allow them to be inserted and removed easily, but the clearance  
20 must be limited to minimise the spread of the coating material beyond the exposed tips. It is therefore required to provide different holders for different diameters of drill if a range of diameters are to be treated. The number of apertures in each array will be  
25 reduced and their spacing increased as the drill size increases, and the depth of insertion must also be increased if the same proportion of the drill length is to be exposed. Beyond a certain size of drill,

therefore, other changes are required.

Figs. 4 and 5 show a holder 22 of the same size and hexagonal plan form as that in the first example, but because it is intended for drills of significantly greater length and diameter, apertured outer walls 24 are provided only on one pair of diametrically opposite sides of the hexagon. In the same manner as the holder of Figs. 1 to 3, the drills are held in corresponding arrays of apertures 6 in the outer walls 24 and inner walls 26 and their depth of insertion is limited by the parallel back walls 28. The inner and back walls are thus provided only on those two opposite sides.

The holders 2,22 of Figs. 1 to 5 are designed to be stacked to form a tower 30, as shown in Figs. 10 and 11, in order to utilize the height of the PVD chamber. Each holder has a bottom skirt 32 stepped out from the outer side walls 4,24 so that one holder can be placed upon another, with a shoulder 34 at the inner face of the skirt resting on the top edge 36 of the outer wall of the lower holder, and the skirt 32 helping to block the ingress of the coating material into the tower. A base unit 42 for the tower, as shown in Figs. 6 and 7, has a platform 44 in which the bottom flange 32 of the lowermost holder is received, located around inner peripheral wall 46 and within outer peripheral wall 48, the walls 46,48 also helping to block any ingress of coating material. The base unit has a central spigot 50 extending below the platform, provided with a socket 50a

to allow the tower to be mounted on a rotary spindle as will be further described below.

The interior of the tower is closed by a lid 52, shown in Figs. 8 and 9, placed on the topmost holder  
5 2,22. The lid has an outer peripheral wall 54 which overlaps the holder outer walls 4 and from which a ring-form first cover plate 56 projects inwards, the lid resting on the holder top edge 36 by the cover plate 56. At its inner periphery, a cylindrical collar 58 projects  
10 upwards from the cover plate 56. A disc-form inner cover plate 60 is secured coaxially over the collar 58 by three spacer ribs 62. The inner cover plate 60 has a dependent collar 64 which is spaced from but overlaps the first collar 58 vertically. A locating stem 66 projects from  
15 the inner cover plate. The arrangement of outer and inner cover plates 56,62 shields the interior of the tower completely from above but the space between the collars 58,64 provides a gas path to and from the interior.

20 The two forms of holders 2,22 described so far are employed in a similar manner in a known form of vapour deposition vacuum chamber V, indicated only in schematic outline in Fig. 10. On the floor of the chamber is a turntable T which is rotated by a motor  
25 drive (not shown) about a central vertical axis in the chamber. A series of vertical spindles S project from the turntable to be rotated by a planetary drive (not shown) in the turntable as it rotates about its central

axis.

Five equispaced towers are mounted on the spindles by the socketed spigots 48 of their base plates and they are positively located with their central axes parallel by a top plate 68 (shown in Fig. 10 only) which is positioned on a central pillar P of the turntable and on the locating stems 66 after the towers have been built up, engaging those stems in a manner which permits them to rotate freely. During the vapour deposition process, which is typically performed at a temperature of 500°C under high vacuum, the towers are rotated continuously with the turntable. Each tower is also rotated by the drives to the spindles on which they are mounted, so that each bank of drills is intermittently exposed to the plasma zones in the outer peripheral region of the chamber to assist the evenness and spread of coating of the exposed tips.

When the coating process has been completed nitrogen is introduced into the chamber to reduce the vacuum and assist cooling. The gas path between the spaced collars 58, 64 the lids allows a convection flow through the interior of each tower so that the drill shanks are also cooled, the flow permeating the full height of the tower from the gaps at the drill flute recesses in the hollow walls. The convection flow through the vented lid gives a more uniform cooling the process cycle time can thus be reduced, without risk of oxidation on the surface of the drill shanks when they

are exposed to the surrounding air.

For the largest sizes of drill it may not be possible to employ the planetary motion in the chamber because of the radial clearance the drills would require.

5 Figs. 12 and 13 show an alternative form of holder for larger drills which is intended to be mounted on a carrier of the form shown in Figs. 14 and 15.

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Like the holders of the earlier figures, this alternative form of holder 82 is arranged to support a  
10 bank of parallel drills in arrays of apertures 6 formed in front and inner walls 84,86, with their points projecting outwards from the front wall by a distance set by a back wall 88 lying parallel to the front and inner walls. Because the holder is not intended to be given a  
15 planetary motion, it has a generally rectangular plan form to hold a single bank of drills with tips projecting from the front wall 84. Solid side walls 90 enclose the interior of the holder and have laterally projecting rear flanges 92.

20 When in use, the top of the holder of Figs. 12 and 13 is closed by a lid which is not illustrated but which can be similar to the lid shown in Figs. 8 and 9. That is to say, it is also provided with spaced inner and outer cover plates shielding the interior of the holder  
25 but assisting a flow of air through the interior for cooling after the coating has been deposited.

A group of six holders of this alternative form of holder 82 can be mounted in a PVD chamber using a

carrier 102 as shown in Figs. 14 and 15. The carrier has a central vertical stem 104, at the bottom of which is a socketed boss 106 that fits onto a central stub shaft C for the chamber turntable, projecting from the floor of the chamber. Pairs of upper and lower arms 108 project  
5 ~~radially outwards from the stem at equal angular~~  
intervals. Secured to each pair of arms is an L-shaped support 110 on which an individual holder 82 can be mounted, with the points of the inserted drills  
10 projecting generally radially outwards.

Each support 110 comprises a main L-shaped bracket 112, the longer inner limb 114 of which is inclined inwards at a small angle to the vertical and is somewhat shorter than the holder it supports. The bottom  
15 of the holder 82 rests on outwardly projecting bottom limb 116 which lies right-angles to the inner limb 114 and the holder back plate bears against the inner limb because of its inclined position.

Fixed to the inner limb 114 of the L-shaped  
20 bracket and extending laterally to each side of it is a supplementary engagement plate 118. At opposite side edges the plate has flanges 120 bent over at an acute angle to its main central face. The width of the central face is sufficient to accommodate the flanges 92 of the  
25 holder, which are then located in the angles between the main face and the flanges 120 so that the holder is prevented from tipping outwards from the support.

A pair of wings 122 extending from the stem 104

below the supports 110 can be engaged by lifting means to place the carrier, with its drill holders, on the stub shaft and to remove from the PVD chamber after coating.

In order to locate the tips of different size  
5 drill tips at their optimum position to the chamber  
periphery for the coating process, it may be required to  
provide a series of carriers 102 in which the radial  
positions of the supports 110 differ.

The examples of holder shown have planar walls  
10 with identical arrays of apertures in each pair of inner  
and outer walls, which facilitates the manufacture of the  
holders. While the radial projection of the drill tips  
relative to the central rotary axis in the chamber then  
varies across the width of each array, this has no  
15 material effect while the angular extent of the array  
relative to the central axis is not large. If desired,  
however, it would be possible to curve the holder outer  
walls to set them at a uniform radial distance from the  
central axis and/or to locate the drills on axes  
20 radiating from the central axis.

Although the preceding description has referred  
to coating only a small part of the length of the drills  
at their tips, it should be understood that holders of  
the form shown can be employed to give fluted drills a  
25 PVD coating over most or all of their fluted length, with  
a suitable modification of the spacings of the supporting  
walls of the holders.

## CLAIMS

1. A holder for supporting a series of drills in a vapour deposition chamber to allow a ceramic coating to be deposited regions of the drills extending from their tips, the holder having a hollow interior and at least one perforated outer wall provided with an array of apertures into which the drills can be inserted with said regions projecting outwards from the holder, within the hollow interior of the holder supports being provided for the inserted drills in the or each said wall for locating the drills with their shanks substantially parallel, and stop means for locating the tips of drills of the same diameter projecting to substantially the same extent from said outer wall.
2. A holder according to claim 1 wherein the stop means comprise a back wall in the interior of the holder, parallel to said outer wall.
3. A holder according to claim 2 wherein an inner wall is arranged between the outer and back walls and is provided with a corresponding array of apertures to said array in the outer wall for locating the drills with their shanks parallel.
4. A holder according to any one of claims 1 to 3 having a polygonal outer periphery, said at least one

outer wall forming at least one face of said periphery.

5. A holder for supporting a series of drills in a vapour deposition chamber to allow a ceramic coating to be deposited on regions of the drills extending from

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5 their tips, the holder having a hollow interior enclosed by hexagonal plan form outer walls, alternative walls of said hexagonal plan form being perforated with an array of apertures into which the drills can be inserted with said regions projecting outwards from the holder, means  
10 being provided within the hollow interior of the holder for supporting the drills with their shanks substantially parallel and with the tips of drills of the same diameter projecting to substantially the same extent from each outer wall.

15 6. A holder according to claim 5 wherein, parallel to each outer wall a perforated inner wall is arranged, said inner wall having a corresponding array of apertures to said array of apertures in the outer wall.

20 7. A holder according to claim 5 or claim 6 wherein, within the hollow interior of the holder a back wall is disposed parallel to each said perforated outer wall for abutment with the inner ends of the inserted drills.

8. A holder according to any one of the preceding claims provided with a lid shielding the hollow interior

from above, said lid being provided with a passage for permitting gas flow between the interior and exterior of the holder.

9. A holder according to any one of the preceding

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5 claims provided with means for stacking of the holder with a second holder having a corresponding outer wall configuration.

10. A holder according to claim 8 having top and bottom faces for abutment together whereby the two  
10 corresponding holders can be supported one on the other, and a flange projecting over said abutment of the faces for providing a closure for the joint between the abutting surfaces.

11. A method of vapour-deposition coating the tips of  
15 a series of drills in which the drills are inserted in a hollow holder having a polygonal plan form with the tips to be coated projecting from at least one outer face of said polygonal form, the holder with the inserted tips being rotated in a vapour deposition chamber to allow  
20 each of the drill tips to project from the holder towards the periphery of the chamber for at least a part of the processing period, and a gas admitted to the chamber after deposition of the coating being allowed to circulate through the hollow interior of the holder.

## METHOD AND MEANS FOR DRILL PRODUCTION

## ABSTRACT

A holder (2;22;82) for coating drill with a ceramic coating by a vapour deposition process has a perforated outer wall (4;24;84) into which the drills are inserted with their tips projecting. The holder has a hollow interior in which support means locate the inserted drills parallel and with their tips projecting to the same extent. The support means may comprise a correspondingly perforated inner wall (8;26;86) and a back wall (10;28;88) against which the drills abut, the outer, inner and back walls being parallel to each other. In one configuration, the holder has a hexagonal plan form with alternate outer walls (4) perforated and each with associated inner and back walls (8,10). The holder is provided with a lid (52) that shields the interior from ingress of the coating material but provides an air passage to assist cooling of the portions of the drills in the holder interior after the coating has been applied.

(Fig. 2)

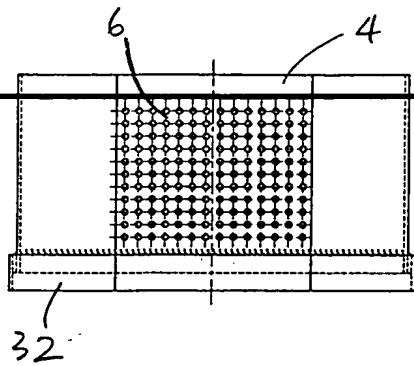


FIG. 1

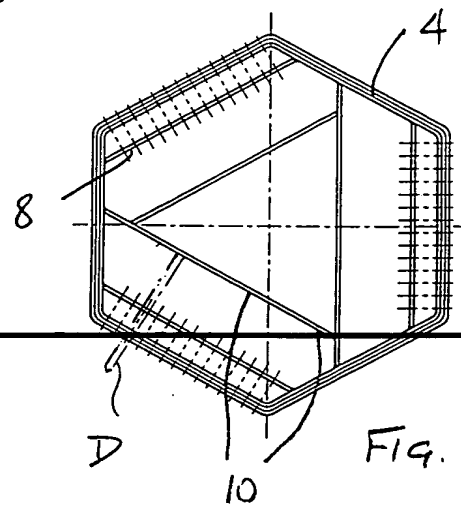


FIG. 2

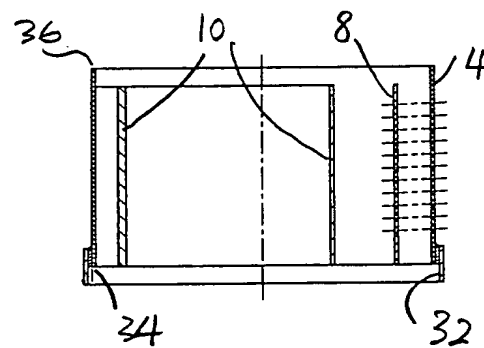


FIG. 3

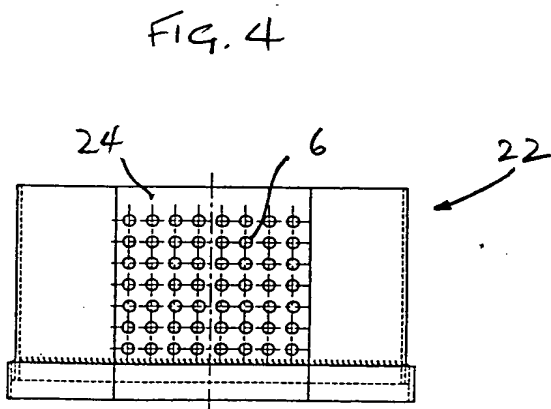


FIG. 4

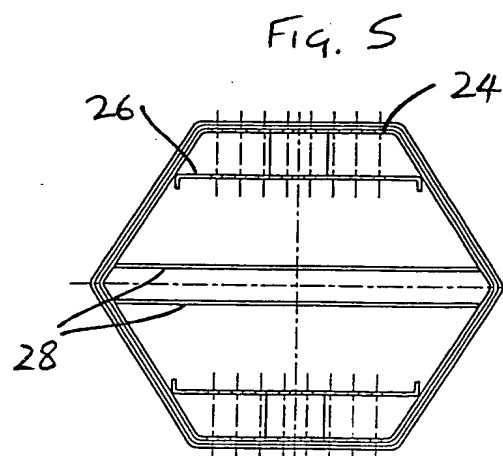
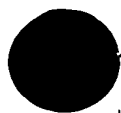
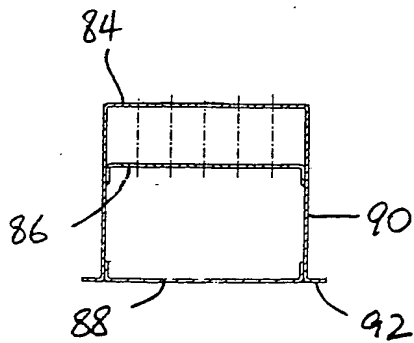
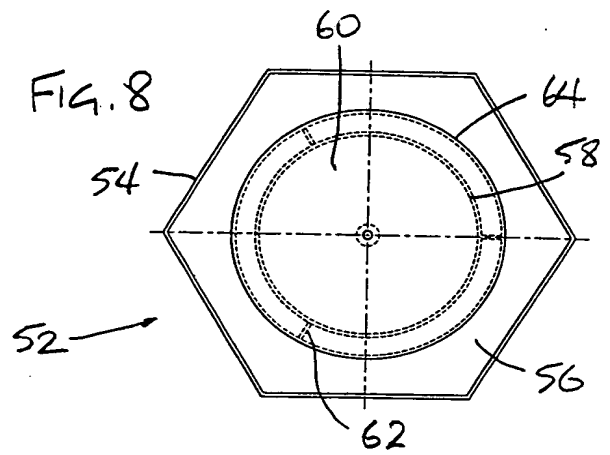
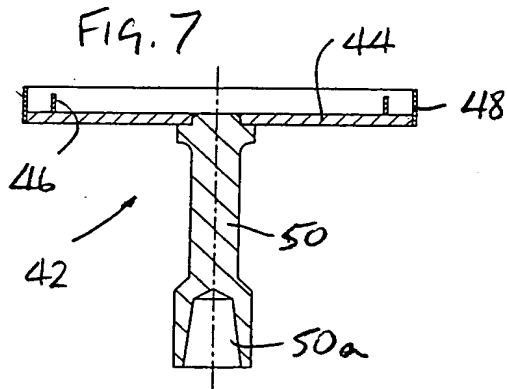
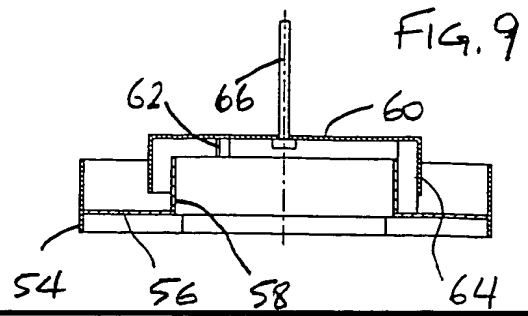
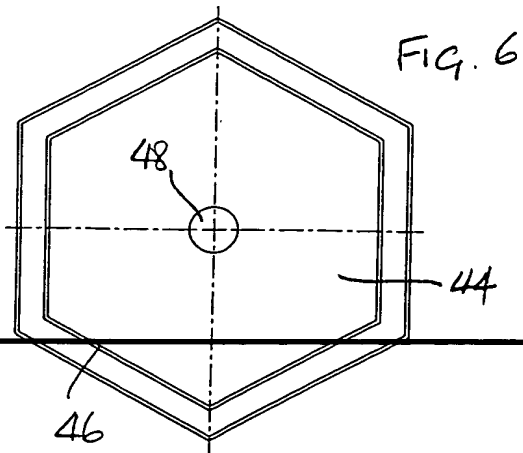


FIG. 5





82 →

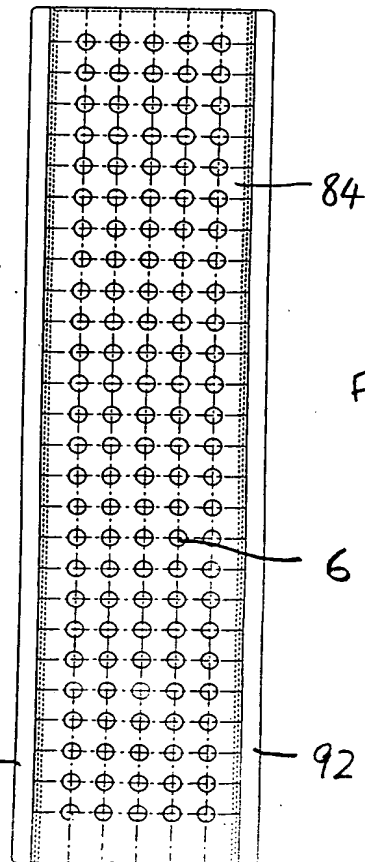


FIG. 12

FIG. 13



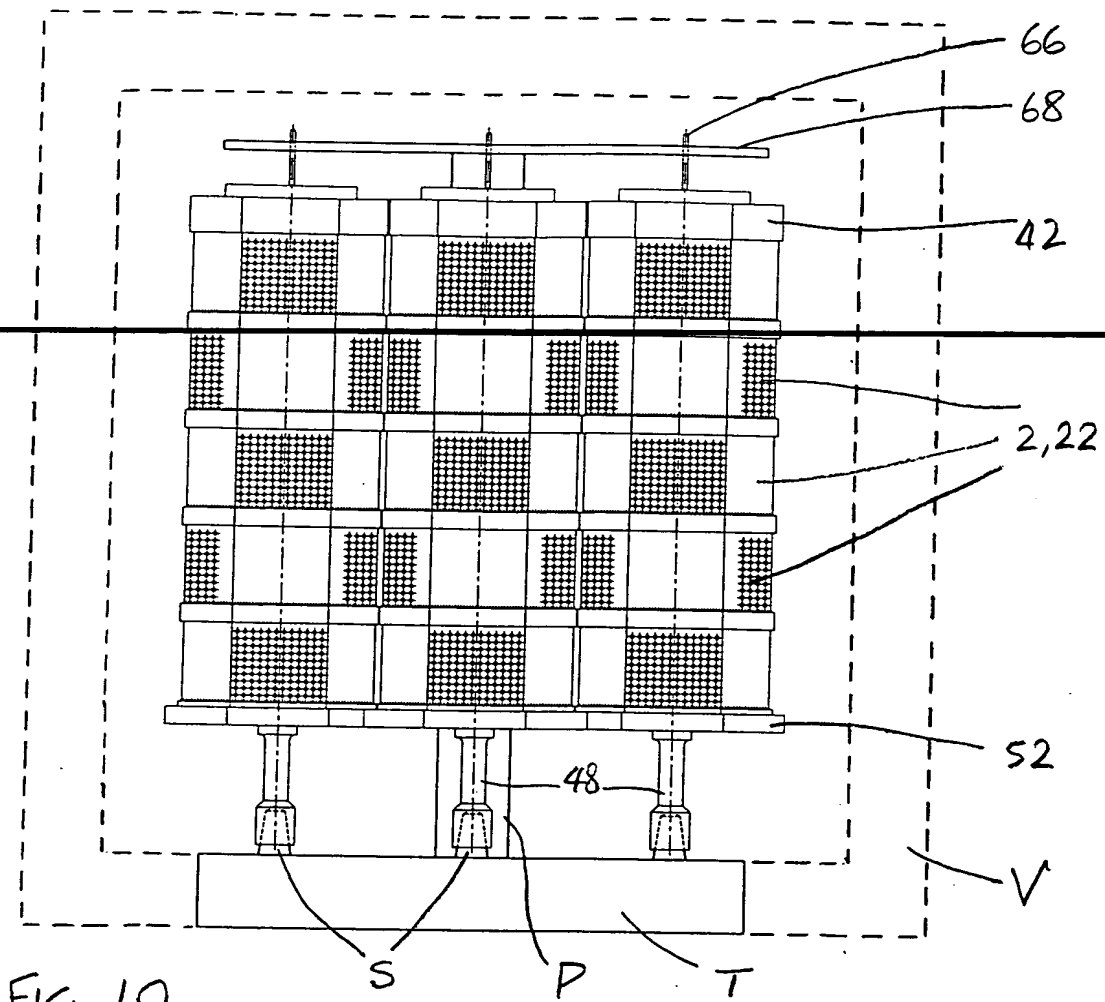


FIG. 10

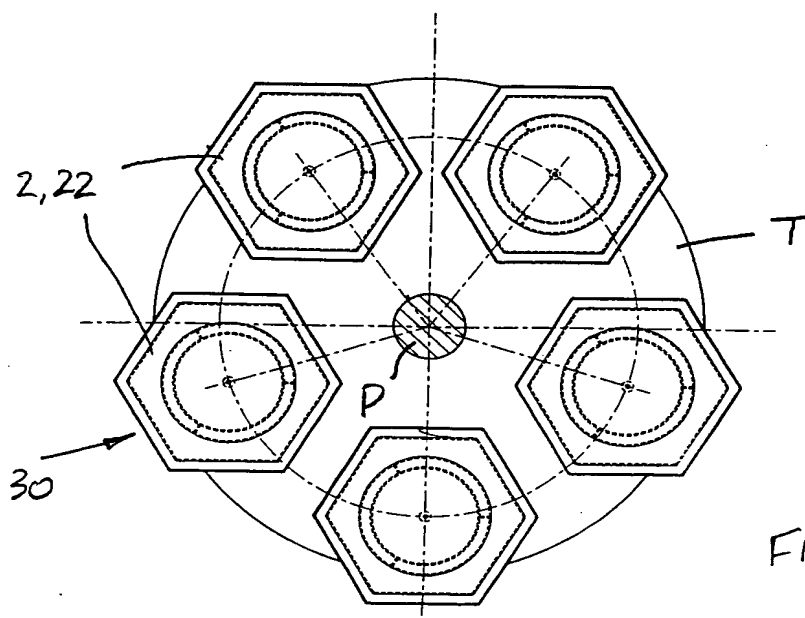


FIG. 11



414

